10/019749
Rec'd PCT/PTO 21 DEC 2001

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Shank-end tool with permanently attached wing-like inserts

This invention relates to a shank-end tool with permanently attached wing-like inserts for the milling-type machining of chipless materials for the manufacture of molds, especially heat-resistant casting molds for producing metal castings.

Primarily sand molds that are made with the help of patterns are used in practice to produce metal castings. Since it is costly to make patterns, there has long been a need to make casting molds by direct machining of heat-resistant molding compositions for small and medium-sized runs.

In DE PS 26 05 687 C3, a cutting and milling tool is used to hollow out a mold cavity to produce sand molds, which is used in active combination with a duplicating miller. The milling tool has a knife assembly with a cutter that conforms essentially to an inverted T-shape and is fastened to an arm that rotates around an axis of rotation. The cutter is interchangeable, it is curved on the outside to smooth the mold surface according to the inside diameter of the casting mold to be produced, and viewed in the direction of rotation it is shaped on the forward edge so that a cutting edge is formed. A hardenable green sand with low strength of 2-5 kg/cm^2 compacted in a molding box is hollowed out with the cutter before the final strength of the molding sand after hardening is reached. This is to prevent fast wear of the cutting edge. The method is relatively difficult to perform because the proper time for the machining has to be provided for during the hardening of the mold. Otherwise the mold becomes dirty with low-strength molding sand, or the cutter quickly becomes unusable with high-strength sand. Furthermore, the milling tools can be used only to make rotationally symmetrical parts.

On the other hand, it was proposed in DD 275 419 A1 to work out a casting mold from a single block of mold material with tools that have no cutter geometry. To produce a cavity in a block of mold material, a device is used that includes a rod-shaped driver driven around an axis on which at least two non-rigid or semi-rigid carriers variable in length are guided. Active machining units are fastened to these carriers and are positioned at identical angular graduations on the driver to avoid imbalance. Flat parts such as triangular plates, stars, or the like, or balls or squares or others with or without edges can be used as active machining units, for example. Cables, wire

cables, sheet metal strips, chains, or the like can be used as non-rigid or semi-rigid carriers, and are provided with additional guard elements to protect against the wear caused by the eroded sand mold material.

To increase excavating capacity, it is necessary during the machining to achieve the highest possible stiffness of the carriers by arranging the machining units to be movable and having them braced against one another. The device can be run under computer control on the arm of a robot. In the same way, it is also possible to control the device by a CNC machine. To improve the surface of the castings, the inner surfaces enclosing the cavity space are sprayed in a concluding step with a smoothing agent, which has to be distributed evenly over the surface. In this case also, it is a drawback that essentially only molds that differ only roughly from rotationally symmetrical parts can be made. The low surface quality of the castings produced with the casting molds is a drawback that can be attributed to the more or less beating action of the tools.

Shank-end millers that have a circular contour are customary for the production of casting molds. The shank-end miller described in DE 197 21 900 A1 has a cutting plate on the free end that is fastened to the shank with tightening screws. The shank has a plate seat with a threaded bore, with the cutting plate being provided with a drilled hole. However, such fastening runs into problems when the dimensions of the cutting plates are smaller than a minimum size. Therefore, it is difficult to loosen the cutting plate or to fasten it satisfactorily. It is also a drawback that the cutting plate is exposed to high wear from chipless materials. This makes it necessary to change tools constantly, which is associated with correspondingly high cost.

To reduce the tool cost occurring from high wear, an economically manufactured milling tool was proposed in DE 3914074 A1 that has a cylindrical shank and a flat cutter support. The cutter support is provided with cutting edges at its edges farthest from the axis of the shank. There are additional frontal cutting plates on the face of the cutter support. The shank is designed as a borer at one end so that the miller can function as a face mill. The cutters are positioned at the radially terminal outer edges of the cutter support relative to the axis of the shank. The cross section of the milling tool shows an S-shaped profile with the cutting edge pointing in the cutting direction. For this reason the previously described miller can be used only for chip-forming materials. Use is not possible for chipless materials.

Foundry sands containing binders bring about a severe degree of wear of the tool cutters, which is caused by wear of the cutters at the cutting edges and frictional wear on the open surfaces. For this reason there is cutting action only with new tools, and there is thus a time limit for it. The cutter wear is manifested as rounding of the forward edge of the tool, which causes additional frictional wear in the area behind the cutting edge. This frictional wear increasingly erodes the outer surfaces and deforms the tool increasingly toward the rear opposite to the direction of rotation. The energy corresponding to the friction is converted into heat, which can lead to heating of the tool and to more rapidly increasing wear.

The problem underlying this invention is to design a shank-end tool for milling-type machining that is simple and economical to manufacture, in such a way that it remains functional with unavoidable frictional wear and with increasing erosion. The machining action should be retained for a lengthy period of time. The losses from friction should be lowered.

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The problem is solved pursuant to the invention with a shank-end tool with a wing-like cutter blade as a cutter insert that has the features mentioned in the characterizing part of Patent Claim 1. The minimal blade thickness brings about a substantial reduction of friction between the blade edges and the casting mold surface, which not only reduces the erosion of the cutter blade but also increases the working life of the tool. Because of this the tool is particularly suitable for high-speed machining, since it has reduced weight and the cooling of the blade edges is increased at high speeds of rotation.

The proposed shank-end tool is composed of easily made semifinished parts, and it can be made economically in this way, which will be described in detail below with reference to an example of embodiment. Other benefits and refinements of the invention are shown in the following description and in the subclaims.

The attached drawings show:

Figure 1 a shank-end tool with a rectangular cutter blade,

Figure 2 a shank-end tool with a cutter blade with arc-shaped blade edge,

Figure 3 a shank-end tool with a cutter blade with rounded blade edges,

Figure 4 a shank-end tool with a cutter blade with angled blade edges,

Figure 5 a shank-end tool with a cutter blade with conical blade edges,

Figure 6 a shank-end tool with a tubular shank,

Figure 7 a shank-end tool with cutter blades positioned with double symmetry,

Figure 8 a shank-end tool with a curved cutter blade convex in the direction of rotation,

Figure 9 a shank-end tool with angled-back cutter blade convex in the direction of rotation,

Figure 10 a shank-end tool with angled-back cutter blade convex in the direction of rotation with obliquely pitched blade edges

in schematic illustration.

The shank-end tool shown in Figure 1 for the milling-type machining of chipless materials, which may include coarse-crystalline sand particularly in the manufacture of heat-resistant casting molds for metal castings, consists essentially of two simple parts that are assembled in a suitable way, for example by interlocking assembly, welding, soldering, or cementing.

The elongated and cylindrical shank 1 rotatable around its longitudinal axis 2 has an upper shank section 3 that can be connected detachably to a tool holder for rotary cutting tools. According to Figure 6, the shank 1 is of tubular design with a hollow body 5. A tubular hollow body 5 offers a substantial saving of weight, which becomes a particularly noticeable advantage especially at high speeds of rotation. Another benefit may consist of the fact that the shank 1, at least in the

area of the cutter blade mount 4, is designed as a tubular hollow body 5. In this way the hollow body 5 can be lengthened with a fitted cylindrical shank section 3 when machining deep parts.

The shank 1 at its free end section 6 is provided with a groove-shaped recess 7 in the area of the cutter blade mount 4, extending in the axial direction, to hold the cutter blade 8. According to Figure 7, by way of example, there are two groove-shaped recesses 7 so that two cutter blades 8 can be positioned with double symmetry. In the case of a tubular hollow body 5, the cutter blades 8 can be interlaced with one another by two opposite half cutaways in the longitudinal axis 2, and can be fastened in the recess 7 in an especially simple way, for example by soldering. This guarantees a secure mount at high speeds of rotation.

The cutter blade 8 can be produced as a punched part by punching from a flat blank of sheet metal or wear-resistant sheet metal, with the invention not being limited to the mentioned examples of embodiment. Instead, unmentioned suitable materials and semifinished products can also be used, if they are within the scope of the patent claims. In particular, this is true for composite materials, fiber composition materials, or high-strength materials or ceramic or fiber-composite ceramic elements.

The cutter blade 8 according to Figure 1 is provided with a non-cutting blade edge 12 on the leading flat side 11 viewed in the direction of advance 9, at a right angle to the flat side 11 when a simple punched part is used. In this case the blade thickness can be comparatively small.

The blade thickness can be 0.1 mm - 5.00 mm. The blade thickness is preferably 0.2 - 1.00 mm.

In particular, the blade thickness should be no greater so that the tangential angle of the flank of the leading blade edge 12 is close to or equal to zero.

When high-strength or composite materials are used, the blade edge 12 and the trailing edge 13 behind the blade edge 12 of the cutter blade 8 viewed in the direction of advance 9 are given a radius or are rounded. Frictional heat and wear are reduced by a small tangential angle and by rounding.

Additional reduction of friction in the area of the trailing edge 13 can be achieved with a cutter blade 8 that has a base material of steel and is joined to a high-strength wear-protective covering 15 on the leading flat face 11. Any hard substance or metal composites containing a hard substance, or a metal alloy or composite material containing a hard substance can be provided as the wear-protective covering 15. Wear of the blade edge 12 becomes lower because of the wear-protective covering 15 applied to the leading flat face 11. The trailing edge 13 on the cutter blade 8 made of steel erodes more severely because of its low strength, so that the flank that has low frictional resistance becomes rounded.

The cutter blade 8 can have diverse forms. Thus different shank-end tools can be used in succession when machining casting molds using CNC-controlled machine tools with automatic tool change, so that the production of complicated molds can be substantially simplified. In the basic form, the cutter blade 8 of Figure 1 and Figures 3-10 has a square or rectangular blank. In Figure 3 the cutter blade 8 is rounded 17 on its face 16, or in Figure 4 it is provided with corners 18 cut off at an angle on the face.

The cutter blade 8 of Figure 2 has an outer contour that has the shape of a circular arc 19, and in Figure 5 a trapezoidal contour 21 can be seen, which produces a cone when rotated around the longitudinal axis 2 of the shank-end tool.

In a particularly beneficial refinement of the shank-end tool, the cutter blade 8 can have convex curvature 22 parallel to the longitudinal axis 2 according to Figure 8, or in Figure 9 it can have convex folding 23 in the direction of rotation 24. If the cutter blade 8 is made of an elastically deformable or springy blade material of low thickness, the curvature 22 can be reduced at higher speeds, as in the case of high-speed machining. In this way the tool radius can be kept constant with increasing wear of the cutter blade 8 because of a speed increase. Metal cutter blades 8 that have high wear resistance are especially suitable for this process. Filigree casting molds that have a very smooth mold surface can be manufactured with the shank-end tools shown, using foundry sand.

To eliminate the machining residues formed during the cutting of the material, it is advantageous for the cutter blade 8 to have shovel-like blade bends 25 according to Figure 10 to produce fan-

like action, by providing a blade angle 26 relative to the longitudinal axis 2. The eroded material residues can thus be carried away from the point of machining primarily in the axial direction.